Large-scale shape transformations of a magnetoactive elastomer sphere

Столбов О. В.[1], Райхер Ю. Л.[1]

[1]*Institute of Continuous Media Mechanics, Russian Academy of Sciences, Ural Branch,* Perm, 614068, Russia

Электронная почта ответственного автора: sov@icmm.ru

General similarity between soft magnetoactive elastomers (MREs) and ferrofluids (FFs), i.e., the combination of magnetic sensitivity and facile deformability, implies occurrence of the effects of surface instabilities (spikes, beaks) in MREs. Moreover, *a priory* prospects for their existence in MREs are more favorable. The differences are clear as well: in FFs the magnetostatic forces elongating the droplet are counteracted by surface tension whereas in MREs these forces compete with bulk elasticity. However, the field-induced transformations of MREs droplets, except for the weak elongation regime, were never investigated nor experimentally nor theoretically. Meanwhile, the shape modulation of MRE samples is of interest not only fundamentally (such measurements provide valuable info on the properties of the material) but equally for practice since it strongly affects the hydrodynamic resistance when driving a sphere/spindle through a liquid.

We present the results of numerical modelling of the under-field shape changes of an initially spherical MRE sample (Fig. 1). Using continual description, we demonstrate that a MRE sphere under the action of a uniform field acquires a spindle-like form with tapered ends. The surface curvature at the polar "cap" undergoes a transition: changes its sign.

An inspiring fact is that, according to reasonable estimates, the effect should be observable without difficulties on typical (not exotic) MREs filled with magnetically soft microparticles under moderate volume content. Besides, for MREs the requirement of smallness of the sample is not essential. The shown images illustrate the initial, intermediate and final stages of the shape transformation of a MRE sphere (only a quarter of the full cross-section is drawn).

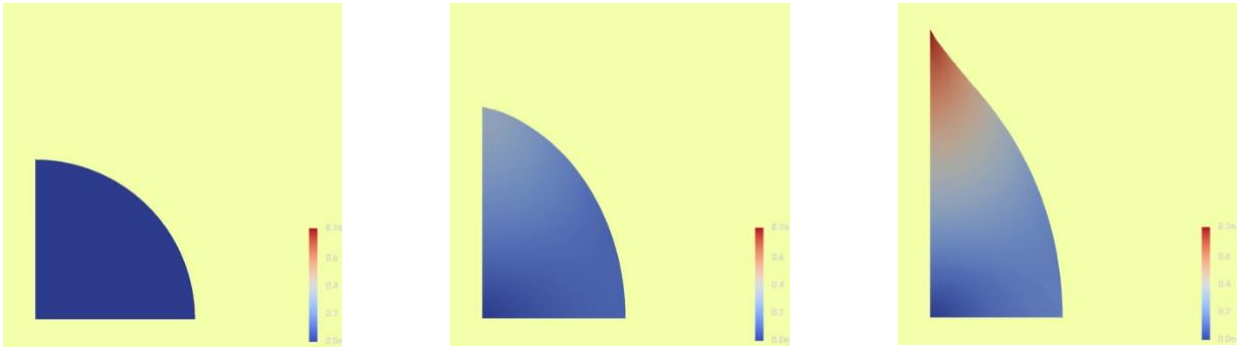

Fig. 1 Modelling of the under-field shape changes of an initially spherical MRE sample